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# Central Eurasia

## AVIATION & COSMONAUTICS

No 6, June 1993

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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

## Factors Affecting Development of Future Tactics Analyzed

*94UM0034A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 10-11*

[Article by Doctor of Military Sciences Professor Colonel (Retired) A. Krasnov under the rubric "Air Forces Tactics: A Look at the Problem": "Aerial Battle at the Threshold of Changes"]

[Text] Military hardware is upgraded in the Air Forces as in no other branch of the armed forces, and that has a direct impact on the development of their tactics. It is not difficult to assume, however, that these two interconnected processes will be accomplished in the future chiefly under the influence of the changes that are planned in the military policy of our state and the significant cutbacks in the size of the Russian Air Forces. Domestic science will have to resolve quite a few issues in this regard that affect, in one way or another, all areas of the military arts, including questions of improving the tactics of aerial battle. The most important of these, in my opinion, are the following.

**What enemy aircraft could our pilots encounter in battle?** This question was as simple as could be during the times of grim confrontation between the Warsaw Pact and NATO: the tactical fighters produced by the United States and the Western European countries. But today we should also add to that... the domestic Su-27 and MiG-29 fighters, whose tactical flight characteristics are highly regarded by aviation specialists around the world.

China and Germany, aside from the traditional buyers (more than 40 nations), have been displaying an interest in these aircraft. The FRG is moreover ready to buy MiG-29s that are not right off the assembly line; the Luftwaffe would also acquire aircraft from combat formations, replacing the engines and electronics on them with newer ones. They have calculated in the West that it would be more advantageous to put an improved version of the Russian MiG into service than to labor over the development of the expensive EFA Eurofighter.

The continuing instability of the military-political climate in some regions, and especially the Near East, also cannot fail to be taken into account in this situation. Armed conflict broke out once more in the Persian Gulf in January, after all, with the active employment of aviation just as happened two years earlier. And who knows, perhaps soon Russian pilots will be taking part in peacekeeping actions by multinational forces in "hot spots" around the globe. They would likely then have to confront these same MiGs and Sukhoys...

The program of testing of the new-generation F-22 fighter is moreover approaching completion in the United States. It possesses, in the opinion of specialists, the highest combat potential of aircraft in this class that are in service today with the air forces of the leading air powers. Failing to mention the fact that the Americans will try to win the world market for aircraft hardware in the future through the sale of this aircraft is to play the ostrich, sticking one's head in the sand at the sign of danger.

The substance of the concept of the "likely adversary," as we see, is becoming more voluminous for our Air Forces, and it must consequently be used with a regard for new approaches to the tactical training of flight personnel in fighter aviation. Just which ones? It is still difficult to answer that question.

**Where will the battle be waged?** We have lost a considerable amount of space with the collapse of the Warsaw Pact and the withdrawal of our troops from Eastern Europe, Estonia, Latvia and Lithuania. The boundaries of our radar reconnaissance and warning of a possible air attack in some sectors have, as a consequence, drawn significantly closer to the groups of forces and important targets covered by fighters in some sectors. And that means that our likely adversary obtains a palpable advantage under these conditions.

It cannot be ruled out that a number of Eastern European countries would not act on the side of the CIS in a military conflict in certain situations. The United States and its allies in NATO are moreover able to create strike forces of troops and air forces in any part of the globe in a short period of time. Suffice it to say that the plans of the American command envisage the redeployment of up to 1,500 combat aircraft from their continent to Europe in 20 days. The possibility of an attack on the part of an enemy with surprise mass maneuvers thus increases sharply in the event of the deployment of air strike groups along our western borders.

The circumstance should also be taken into account that the entry into service on a mass scale of means of aerial attack manufactured using Stealth technology, strategic cruise missiles using conventional ordnance and other types of high-precision weaponry would lead to a significant change in their operational structure in operations and strikes. The latter would obviously not have strict time frames, and could be carried out in waves for a prolonged period from various directions, accompanied by strong electronic suppression of troop command-and-control systems and weapons to as much as theater depth.

The opportunities for the timely entry of fighters into battle from a status of ground alert duty and the intercept of an airborne enemy in the distant approaches to the targets they are covering are sharply restricted under those conditions. The sole way out of this situation, in my opinion, is transition to a means of waging combat operations that is in this case not economical—fighter airborne alert status. What else can be done?

**How will the battle be waged?** The fundamental rules that were devised and codified in local wars and armed conflicts in the last thirty years will obviously remain in force for the next decade as well, if not longer.

There would seemingly be no need in this regard to discuss today the upheavals in air clashes between fourth-generation aircraft. But let us nonetheless try and answer a question: How, taking into account the cutbacks in our fighter aviation, can we achieve the maximum realization of the combat potential of the Su-27M and MiG-31, which—it is no secret—will in the near future constitute the foundation of the aircraft inventory of fighter and PVO [air-defense] aviation? How can we learn, in other words, to fight using skill rather than numbers? We will proceed therein from the fact that the tactics for waging aerial battle by the crews of those aircraft are founded chiefly on the use of the "recommendations" of on-board expert systems and the delivery of high-precision weaponry.

The search for an airborne enemy by the crews of fighter interceptors could thus be accomplished through its preliminary detection by velocity, with the further tracking of several targets according to the ranges measured using the automatic selection of pulse repetition frequencies for the on-board radar and the depiction of symbols (corresponding to target range and speed) on a display in the cockpit of the interceptor. An on-board thermal direction finder and laser rangefinder could also be used for the concealed surveillance of the overall aerial situation. All of the subsequent measurements of range to the target are made using the on-board radar.

Assessment of the tactical situation is performed, by and large, by the on-board expert system. After the detection of a group target, for example, it establishes the quantity and place of each aircraft in the group and determines their affiliation and priority without the intervention of the pilot, after which all targets are ranked according to the degree of danger and the most dangerous are put onto the display.

The commander of the interceptor group must make the decision to enter into battle in the next stage. His plan could be as follows: having detected one or several targets, the pilots take up a tactically advantageous position with regard to the enemy and make a concealed approach to him. Each distributes the guided missiles on board the fighter against the targets assigned by the group commander, and tracks them until such time as his aircraft is at a distance from one of them that corresponds to the maximum permissible range of weapons delivery. It only remains to execute the missile launch and disengage, using vigorous maneuvers guaranteeing the safe evasion of possible return fire from the enemy. The group commander, depending on the situation and the results of the first attack, then either organizes another pass or assigns his subordinates the task of finding new targets.

But how, say, can battle be waged if the enemy has both a quantitative and a qualitative superiority? This is far from a rhetorical question, if one takes into account the significant cutbacks in the funding allocated in the Russian budget for the continued development of the latest models of military aircraft. This problem is obviously in need of serious analysis. The basis for it could be a consideration of the combat tasks of fighter aviation.

You will agree, whatever contemporary aviation systems it may be equipped with, that it will have to wage battle only for tactical supremacy in the air—that is, in a restricted area and in the most crucial periods of combat operations—using small forces, with the observance of the principles of mass and centralized application.

If the likelihood of a large-scale war against Russia exists, then it is only potentially, in the long term. But local military conflicts are making themselves known even today, and require the appropriate level of readiness of our Air Forces. It must therefore be taken into account, when preparing them, that combat operations in local conflicts, as a rule, are of a localized nature; there is not always a clearly outlined front line; and, raids of enemy aviation are possible from various and most unexpected directions. Fighter aviation, aside from its basic "classical" tasks, will have to perform a new one as well in this regard—supporting the redeployment of mobile forces to the "hot spots." But if the prevailing geopolitical situation of Russia, the large spaces and the poor sophistication of the airfield network are taken into account, then in my opinion it is difficult to count on efficiency in the maneuvering of fighter units and their concentration in the threatened areas in the event a military conflict breaks out.

Quite a few difficult-to-solve problems of this sort have unfortunately accumulated in the tactics of fighter aviation in our Air Forces, since it has gotten into a state of anabiosis, figuratively speaking, in its development. One unequivocal conclusion suggests itself here—although its basic provisions remain in force, the necessity would seem to have become urgent to expand them and bring them closer to the realities of the present day. At this stage, when the formulation of the military doctrine of Russia is approaching its conclusion, it is more desirable than before to devote attention to the theoretical elaboration and practical assimilation of questions of preparing and waging combat operations by its Air Forces, and first and foremost fighter aviation.



## Myasishchev EMZ Tests Versatile Manned Air-Dropped Rescue Module

*94UM0034B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 12-13*

[Article by A. Zhiltsov under the rubric "Flight Safety: Search, Resolution": "The Rescue Capsule..."]

[Text] *...increases considerably the likelihood of rescue for people in accidents on land or at sea, as well as in natural disasters.*

Aviation hardware is improved from year to year, but unfortunately it cannot yet be said that the number of accidents and crashes is being reduced, and people are killed every year. But it is not a matter of the hardware alone—natural catastrophes, before which people are helpless, make their contribution as well. But we are quite able to reduce the number of casualties; we need only take up the matter seriously and remember that the greater number of lethal instances are observed in the first hours after a disaster, when shock, confusion, disarray, serious injuries, great loss of blood and lack of essentials lead to irreversible consequences. Suffice it to recall the demise of the Admiral Nakhimov, the earthquake in Armenia or the tragic incident with the submarine in the bitter polar waters. So many casualties could have been averted if help had come even an hour sooner!

The rescuers, it is true, did not arrive on time in those specific cases for entirely objective reasons—the remoteness of the location of the catastrophe, the lack of the equipment necessary in such cases, damage to rail sidings and airfields. Only air drops of specialists and technical gear, and moreover immediately, could have radically altered the situation. Far from every specialist, unfortunately, is able to make a parachute jump, the more so into an unprepared area or into the water, in many cases in pitch darkness as well. The rescuers themselves could be turned into the target of rescue as well in bad weather conditions or on rugged terrain. One also cannot fail to take into account that the separate dropping of people and gear often leads to unjustifiably large losses of time.

An analysis of catastrophes and natural disasters that have occurred makes it possible to conclude that the effectiveness of first aid measures, and all aid in general, is determined by the following conditions:

—the availability of means to deliver rescue gear, equipment and rescuers to the site of the catastrophe;

—the presence at the site of the catastrophe of specialists who can provide for the effective utilization of emergency-rescue and medical equipment in the area of the catastrophe or natural disaster;

—the time to bring the gear into readiness for utilization.

These conditions are met only through the air drop of highly trained, first-class specialists together with the appropriate gear (equipment).

A special container for the group air drop of rescue specialists and the necessary gear has been developed for just that purpose at the Experimental Machine-Building Plant [EMZ] imeni V.M. Myasishchev.

It must be acknowledged that work on this type of descent apparatus had already been pursued, but not at all for the purposes that we are talking about. The idea of the possible application of this container in rescue operations appeared only in the middle of the 1980s, largely thanks to impending conversion.

Two versions of the apparatus were developed—one with uncontrolled parachute descent, and one with controlled parachute descent and an engine for movement in the water.

Several containers of the uncontrolled type have been built over the last seven years. They have completed the stage of design testing, and have been tried out in dozens of drops both without people and with people on board. This container is currently ready for series production. It is manufactured of duralumin, and is cylindrical in shape. The weight of one fully equipped is 2,300 kg [kilograms], with a carrying capacity of five people plus 300 kg of cargo (one tonne in the cargo version). The drop altitudes range from 400 to 8,000 meters.

The testing was conducted using An-12, Il-76, Tu-95 and 3M aircraft, and had positive results. The parachute system employed on the container is the same as the one on the Soyuz descent craft, and operates according to the configuration of forced deployment of the drogue parachute—actuation of the stabilizing system—deployment of the main system. A reserve parachute is also planned. The rated G-forces should have been 15 when the main canopy opened; in experimental drops they rarely exceeded 13 (10—13). The time for operation is 0.05—0.1 second.

The crew of the container is accommodated in Kazbek seats, the type installed in the descent craft of the Soyuz spacecraft. They are somewhat modified in this version, and have inflatable cushioning. The container is entirely airtight with an oxygen reserve on board for five hours, along with communications gear and a source of electric power. The craft is very easy to operate and sits low in the water, making it easy to fish people and various essential objects out of the water, much easier than from a rescue boat. The rescue module has a good stability reserve thanks to that low center of gravity and the presence of special runners. The wave crest washes over the container when performing operations at sea in storms of three or more, rather than swamping it. The container maintains its orientation, thus surpassing the means of sea rescue currently in existence, from cutters (Yersh and Gagara class) to the not-very-widespread ground-effect craft.

The design engineering of the rescue capsule allowed for five drops, but testing has shown that its durability is considerably greater. All of the capsules withstood use more than ten times, and one container was destroyed only on the 48th drop.

The controllable capsule is still in the development stage, during which a host of difficult problems will have to be solved—automatic controlled descent and landing on a very restricted site in particular. The second version of this item, despite the outward similarity, differs substantially, first and foremost in the parachute system, which can be actuated at once, *i.e.* without the use of a drogue chute and stabilizing system. The canopy of the main system is controlled either automatically or by commands from an aircraft, the ground or right from the descent craft. There is also a reserve parachute system.

There are four Kazbek seats installed on board, but without cushioning, and one heated seat. The weight of the cargo is 300 kg in the cargo-passenger version (1,000 kg without passengers). A 40-horsepower engine started from a generator, even in the air if necessary, is planned for movement in the water. The craft can be in autonomous mode for no less than six hours with continuous operation of the engine and generator.

The circle of tasks that can be performed with this object is very broad. It includes first aid to the stricken or the supply of electric power sources, special tools, tents, foodstuffs, etc. in the initial stages of an air-rescue operation with the joint drop of people and special gear. When it is dropped in the cargo version, units ready for operation immediately after landing (compressors, certain types of medical equipment, heaters, firefighting gear, water-pumping modules, special equipment for scuba operations etc.) can be supplied. The role of the new rescue craft is particularly great in the delivery of geological parties and expeditions in remote and difficult-to-access regions, their supply and the performance of repair operations on electric-power transmission lines and trunk gas pipelines, as well as supplying populated areas in the event of natural disasters.

The container may also be used as a storage device, as well as an intermediate base during Arctic and Antarctic crossings.

It is difficult not to agree that the craft that have been developed at the EMZ imeni V.M. Myasishchev are promising and extremely necessary in today's unsettled times. The work, however, is nonetheless not proceeding as it should. There are problems with everything—the parachute fabric, the materials and constituent items, the testing. One would like to believe that these are temporary difficulties. Interest in obtaining these containers is being displayed abroad as well, where nothing analogous has been created.

## Delegation Checks on Advanced Training Methods at Kachinsk VVAUL

*94UM0034C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 14-15*

[Article by A. Voynov under the rubric "Military Reform and Higher Educational Institutions": "A Union of Science and Practice"]

[Text] A prestigious delegation arrived one sunny day at the Kachinsk Higher Military Aviation School for Pilots [KVVAUL] in Volgograd. It included two-time Hero of the Soviet Union and Pilot-Cosmonaut of the USSR Lieutenant-General of Aviation (Retired) G. Beregovoy, RAO [Russian Academy of Sciences] Academician and Major-General of the Medical Service (Retired) V. Ponomarenko, Honored Test Pilot of the USSR V. Tsuvarev, writer A. Markusha, and staff members of the Institute of Aviation and Space Medicine (IAKM) candidates of medical sciences Colonel A. Vorona and Lieutenant-Colonel S. Aleshin.

That same day the guests visited the museum of the storied school, made entries in the Book of Honored Visitors, visited the library, where they left gifts appropriate to its purpose, and then met at a roundtable with cadets, flight personnel and the instructors and command of the KVVAUL. Far from all of those wishing to be invited to the discussion were so invited—only cadets and officers taking part in the scientific-research work (NIR) under the name of Banan, which has been underway at Kacha under the aegis of the IAKM since September of 1990. The theme of the work is "Elaboration of Methods for the Development and Evaluation of the Intellectual Capabilities of VVAUL Cadets."

Without going into detail, we will clarify that the discussion concerned a fundamentally new approach, based on contemporary scientific ideas and experimental data, toward the selection and training of future military pilots, an approach oriented toward the contemporary and future level of development of combat aircraft. Ideas of the intellect as the ability of the person to adapt to various situations, learn and successfully resolve tasks in various types of activity are at the basis of the Banan NIR.

The authors of the NIR distinguish practical and theoretical types of intellect, singling out three factors in the structure of the intellect of a practical type: logical-symbolic, reflecting an ability for the analytical processing of information; spatial, reflecting an ability for the synthesic processing of information; and, working memory, typifying the properties of the brain as a biological processor. Intellectual abilities (IS) are assumed to develop in the following directions: the formation of a high intellectual level by means of intellectual training; the incorporation into professional training of the principles of evolving training; and, the effective application of technical means of training (TSO).

The experiment has been underway at the KVVAUL since 1990. One of four groups of cadets—average according to initial data—is being trained using the IAKM techniques oriented toward the development of the memory, logical thinking and the ability to perceive information quickly. Video and audio technology were used in purposeful fashion with this group for the development of professionally important IS for the first time.

An IAKM—KVVAUL practical-science association was created in the course of the experiment. It includes instructors from the departments, specialists from the psychophysiological laboratory, a professional-selection group and officers from the flight-instruction department (LMO). A special department for the fundamentals of flight training organized at the school acted as coordinator of the experiment.

The reporting on the stages of the Banan NIR shows positive results. They became the foundation for all cadets, starting with the incoming class of 1991, to be shifted to training according to the techniques recommended by IAKM. The discussion at the roundtable was about what this has given the cadets in the experimental group, how they feel and what they have achieved, a group that has now been transformed into a leading one in composition, tasks and results of training. We offer you a record of the discussion.

**Candidate of Medical Sciences Lieutenant-Colonel of the Medical Service S. Aleshin, senior executor of the Banan NIR:**

—The increase in the intellectual capabilities of the cadets in the experimental group (EG) surpassed the analogous values for their classmates by twenty-nine percent for the spatial factor and by more than nine percent for the logical-symbolic. The EG achieved better values of progress in studies, and had better characteristics of the distribution of attention, spatial orientation, and nervous-emotional stability in flight. The dual-instruction program was completed at higher quality. There were six times fewer cadets dismissed from flight work owing to poor progress in the EG than in the control group. The results obtained, as well as the data from prior research, made it possible to recommend the adoption of the techniques for evaluation and purposeful intellectual development into the training practices of the Kachinsk VVAUL.

**Colonel G. Cherkovskiy, chief of the flight-instruction department of the school:**

—The technique of flight training has remained virtually unchanged since the beginning of the century. The hardware and tactics, however, moved far ahead long ago. The IAKM technique—the methods of evolving training and the formation of a mental image of the flight using TSO before the start of practical flight work—is having a palpable effect. The EG cadets are demonstrating a clearly pronounced desire to fly.

The successful incorporation of the new system is being slowed by the lack of TSO. We would have been able to accomplish little without the help of IAKM. The new is being perceived equivocably by the flight personnel—"I will teach the way they taught me..." There are enemies of the innovations at the school. We know about that, and are dealing with it. We plan to conduct the centralized retraining of instructors this year.

**Lieutenant-Colonel V. Timofeyev, squadron commander:**

—Two conditions are important for success in training—a healthy cadet collective oriented toward flights, and instructors who can and are ready to teach. We felt the results of the work that was carried out under the Banan program in the training section. This was manifested first

and foremost in a clearly pronounced motivation of the cadets for flight training, and in an increased mutual understanding between them and the instructors. The lack of contemporary TSO, meanwhile, had a negative impact on the results of the work. All we have in the regiment is a slide projector—yesterday's equipment. Modern TSO is vitally necessary. They took the last MiG-21 from us here as late as 1990. The flight training has been conducted since that time exclusively on L-39 aircraft. A "psychology of the subsonic aircraft" is being formed here regardless of our efforts. After the L-39, far from everyone can master the MiG-29—the difference is colossal. The training detachment, making use of all available TSO, should provide as much information as possible about the aircraft our graduates will be flying.

**Major-General of Aviation V. Nabokov, chief of the school:**

—Let us take a look at who is studying at Kacha today. About sixty percent of those in the first and second years are the children of servicemen. There are virtually no representatives of the peasantry or the intelligentsia. Both we and the scientists have something to think about there. When we were analyzing the results of the work in 1992, it became clear that the cadets were sometimes better trained than the flight personnel in a theoretical regard. Those who go into the training regiments this year will be stronger than the instructors in theory. But our cadets understand that only the instructor pilot "teaches the sky." Cases of conceit and conflicts on these grounds are not known to me.

The regiments lag the training detachment for objective reasons. The techniques being employed do not reach the flight personnel, and are being incorporated with difficulty. This is largely explained by the uncertainty of the status and prospects of the instructors, and the reduction in motivation for conscientious flight work.

Modern TSO is essential—both video and audio systems, along with personal computers at levels down to the squadron inclusive.

Last year was unusually difficult in a morale, and not only a logistical, regard. Having received the appropriate authority, I told the cadets frankly from the rostrum that they have no prospects here, let whoever wants to go out and find himself another place in life. Today I can state with all certainty that whoever wanted to leave has done so, and we will work with those who have remained.

**Cadet A. Ustinov:**

—Has the new technique helped us in the experimental group? The impressions are ambiguous. It is difficult to judge for oneself the use of a method of strong points or static slide films. The video films were undoubtedly of use for landing, the practice zone, pattern work. But the videos that were shot at the school are not distinguished by their high quality. They do not reflect the specific "nuances" that the cadet needs. The impression is created overall that there is some benefit from the technique. But I cannot speak for everyone. We are all different, after all...

**Colonel V. Kryuchkin, chief of the flight safety service of the school:**

—There is no need to draw far-reaching conclusions—it is too soon. Yes, there are some results: the EG looks better off than the others. But perhaps that is the result of an unstable dual-instruction program? Half of the cadets who were dismissed for lack of progress in the other squadrons, by the way, could have stayed. The question of dismissal was resolved personally at the highest level for each cadet in the experimental squadron. Who else could boast of such attention? No one. I would have let go just one of the three who were dismissed from the experimental group, by the way. The Banan program must be continued and improved. The image of the flight on the basis of a homemade video film gave cadet Ustinov from ten to fifteen percent harmful skills. And he could not have avoided them until he was looked after. Then he understood everything.

**Colonel A. Shirokov, deputy chief of the school for personnel work:**

—It really is too soon to draw conclusions. We urged people to be discharged, we repeated the lack of prospects. But today we are talking about a particular type of intellect characteristic only of the pilot, about a tendency toward flight work. And the fact that there is still anybody to hear it is the main result. Our cadets have not broken, have not despaired of their choice. They want to fly and learn. That, in my opinion, is the chief result of the NIR.

A few observations. The work, having in mind the NIR, is undoubtedly useful and necessary. But it seems to me that it is oversaturated with an unjustified academism, it is overscientific. Success is assured with more popular accessibility and understandability. Provided, of course, a system of appropriate selection and training of instructors is instituted.

**Lieutenant-General of Aviation (Retired) G. Beregovoy, two-time Hero of the Soviet Union and Pilot-Cosmonaut of the USSR:**

—They want to make Nesterovs, pilots of great prospects, out of you with the aid of the IAKM techniques, through the development of the intellect, through the personality of each. When we evaluate an aircraft today, we have the average pilot in mind. You will not be average if you make conscientious use of the opportunity you have been granted.

I am sometimes asked, How did you survive the war? I will try to explain. First of all, I always noticed the enemy faster than the escort fighters, and I targeted them myself, trying to force my will onto the enemy and anticipate the development of events. I tried to learn from the mistakes of others, and never blindly trusted instructions—real life is so varied that you can't always envisage everything. It is very important to feel the aircraft, to understand what is happening and what will happen if you do this or that. You have to think and predict the situation.

When I was shot down once, I had to land my aircraft in a forest. The instructions recommended using it as an underlying surface. I knew that a pilot had recently died in an Il-2 by making a forced landing in the woods according to the instructions. I did not want to repeat his fate, and I decided

not to "shave" the crowns but to slash to the roots. It did not work out too badly. The wings and tail disappeared. But I was left alive!

**A. Markusha, writer:**

—An example for my generation was Valeriy Chkalov. It can be seen distinctly today, however, that some writers and commentators of the times, most likely out of opportunistic considerations, have created an image of a diminished intellect. Yes, Chkalov had no education. And so what? Chkalov was not simply an outstanding pilot, but also a highly gifted and intellectually refined individual. I have had occasion to read his letters. Chkalov had neat and legible handwriting, and he wrote without errors!

There is no profession in the world that would give one such a feeling of freedom as the flight profession. And if you have decided to refute slavery with all of your life, you are in the right place. I see the sense of life in seeing that it is not wretched.

**V. Tsuvarev, honored test pilot of the USSR:**

—It becomes clear in a detailed analysis that not one normal test pilot does or could conform to the optimal professional requirements and handle his duties anyway. In what way, through what is he able to do this? The fact is that a person who is very imperfect from the standpoint of the requirements of professional selection adapts and compensates for his uncorrected shortcomings, developing and improving his merits. The test pilot Anokhin, for example, as is well known, flew with one eye. What you are given is thus directed toward the development of those qualities that will later allow you to become true pilots.

**Major-General of the Medical Service (Retired) V. Ponomarenko, Academician of the RAO and scientific supervisor of the Banan NIR:**

—You have met with some prominent people today. Understand that you are future military pilots. And the pilots are the flower of the nation, the bearers of the traditions of good, decency and culture. Pilots are a special world, a special atmosphere. A feeling of personal dignity, not self-importance, can exist only in a professional. So move toward it through professionalism, through intellectual development.

The personality of the pilot starts with self-evaluation: where do I stand, what can I do and what can I not? You have to be honest to the utmost, answering these questions for your own self.

It is very important to raise the level of training of instructors today. An instructor who has never in his life flown a modern combat aircraft cannot give a cadet true purpose, and does not know what a MiG-29 or an Su-27 is. A higher school for instructors is needed. An instructional center could be created at the school as a start, and then a school could be opened. We will not be able to move forward if we do not solve this problem. And do not grow conceited as you are working, let people surround you who meet good with good...

* * *

The next day all who wished were invited to a meeting with the guests at the school's club. The meeting was warm, the climate was relaxed. And you had to see the agitation, the embarrassment with which the young lads in their cadet's epaulets brought up their record books with the addresses of their relatives and the telephone numbers of girls, so as to leave in their memory the confident stroke of the pen of two-time Hero of the Soviet Union and three-time pilot Beregovoy... There were many revelations that day that give me grounds to assume that Kacha will remember this visit for a long time. And if that is so, then it may be asserted that its aim was achieved.

Before the war, as is well known, Kacha was located in the Crimea near Sevastopol. There was also a branch there of the predecessor of the IAKM—the IAM [Institute of Aviation Medicine] imeni I.P. Pavlov. The school and the branch worked closely together to their mutual benefit. Then fate separated the scholars and the practitioners. The IAM has since been disbanded, resurrected and had "space" added to its name. And now they are together again—the storied school and the unique scientific-research institute of the Air Forces. Their collaboration, directed toward the future, is having results even today. That is indisputable. A delegation from the French Air Force that visited Kacha at the end of March admired the intellectual level of the IAKM projects that had been incorporated into the training program. The French frankly admitted that they did not yet have anything of the sort.

There is no need, by the way, to hold absolute the opinion of the representatives of the French Air Force. We have our own as well, after all—the IAKM and the KVVAUL are pursuing a necessary, useful and undoubtedly promising cause hand in hand.



## Possible Causes of 1992 YF-22 Crash at Edwards AFB Reviewed

*94UM0034D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) p 31*

[Article by Professor Colonel-General of Aviation (Retired) V. Filippov under the rubric "Aviainform": "Accident of a 'Stealth'"[1]]

[Text] The new YF-22A fighter suffered an accident on 25 April 1992 at the U.S. Edwards Air Force Base (California) during plant testing. The ATF program, under which the aircraft was being developed to replace the F-15, was partially classified, but for a certain circle of specialists it was no secret that the work is being conducted in order to create an advanced tactical air-supremacy fighter. The requirements posed toward it are also convincing in that regard—high effectiveness in aerial battle outside of visual contact with the enemy, use in good and bad weather conditions and in day or night, and support for double the number of aircraft-sorties per day with a reduction in support personnel. The aircraft should also have supersonic cruising speed in non-afterburner engine operating mode, low detectability and the possibility of being operated from runways 450—600 meters long.

Lockheed and Northrop, with experience in the development of the F-117 and B-2 Stealth aircraft, were selected first for the realization of the project in 1986. After the first

flight tests of the experimental aircraft (the YF-22 and YF-23) in August and September of 1990, however, the working design engineering for the pre-series-production aircraft was entrusted to Lockheed. The firm's product had advantages in maneuverability, controllability and detectability indicators. The latter quality was attained thanks to the fact that essentially all of the achievements of the Stealth technology—low-reflecting shapes, radio-absorbing materials and electronic-warfare gear, among others—were employed on the fighter. The radar signature (EPR) of the YF-22 in some aspects from the forward hemisphere, according to some assessments that leaked to the press, is about one percent of the EPR of the F-15. This, in the intent of the designers, should reduce by 5—10 times the effective range of missiles against it.

Engines with non-controllable air intakes and flat nozzles fitted with a system to divert the thrust vector have been installed on the aircraft. They develop thrust equal to roughly 156 kN in a static afterburning mode. An excellent aircraft by all measures, whatever one may say. The failure that occurred, however, has somewhat reduced the optimism of its advocates.

That day, going around after a missed approach, the fighter unexpectedly dropped to the runway and caught fire after several cycles of powerful vibrations on the vertical plane. Test pilot Tom Morgenfeld, even though he sustained burns, was able to get out of the cockpit in time.

The precise cause of the accident has not yet been established, but specialists have already advanced a number of options. The assumption arose that changes in the magnitude and direction of the thrust vector in afterburner mode of engine operation could occur. Such a situation had not been studied before.

U.S. Air Force Chief of Staff General McPeak holds a different opinion. Insofar as it was established in the initial stages of study that the stabilizer of the YF-22A has larger angles of deflection when the landing gear is down than when it is up, it is namely for that reason that the electronic control system should be subjected to careful checking. General McPeak at the same time does not conceal the difficulties in determining the cause of the accident, owing to the destruction of a considerable portion of the aircraft during the half-hour fire. The flight data recorders and the data of telemetric measurements, all of which remained intact, save the situation.

It has been established that the vibrations of the aircraft on the vertical plane began after the pilot, when going around, turned on the afterburner and retracted the landing gear. Significant vibrations in the stabilizer, typical of the unsteady operation of the electronic control system, were recorded at that time. The deflection of the nose of the aircraft from the trim position reached 20° upward and 5° downward for obviously that reason as well. The landing was also at an angle of attack greater than that allowed.

Specialists have determined that the speed of the fighter was within allowable limits, and no signs of a separation of the airflow on the wing were observed.

Many, however, feel that the possibility cannot be dismissed of the consequences of flaws or specific features of the behavior of the aircraft that had simply not been studied in this stage of testing. Turning on the afterburner in conjunction with controlling the thrust vector, for example, had only been done before at high altitude and, naturally, not during the process of retracting the landing gear. The possibility of the appearance of aircraft rocking owing to the imprecise actions of the pilot with the control stick, which on the YF-22 is mounted on a side panel and has a range of motion of just three quarters of an inch form the neutral position, had not been checked out.

Answers to all of these questions would seemingly be provided by more profound study, both of this particular incident and by further testing of the undoubtedly successful craft. As for this particular copy, it is not subject to restoration, since 20—25 percent of its structural elements were destroyed by fire.

The report of the U.S. Defense Department that this accident will not entail serious delays in the deadlines for the completion of testing sounds entirely justified. More than three quarters of the planned program of test flights had already been made successfully before it happened, after all, and the characteristics of the aeroelasticity of the aircraft had been obtained and the interference of the weapons systems had even been measured. Data had been obtained even earlier regarding vibration and acoustic loads on a special aircraft.

The second of the two YF-22 aircraft built, however, is evidently not suited for flights, and the flight testing will be able to be renewed only after the building of an experimental F-22 in 1995.

**Footnote**

1. Based on materials in the foreign press.



## Profiles of Russian RSR and Lockheed SR-71 Reconnaissance Aircraft

*94UM0034E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 32-33*

[Article by M. Levin under the rubric "Information for Reflection": "High-Altitude High-Speed Reconnaissance Aircraft"]

[Text] *The need for the guaranteed receipt of reconnaissance information in depth on enemy territory covered by powerful contemporary PVO [air-defense] systems forced the aviation designers in the USSR and the United States, in the second half of the 1950s, to turn to the idea of creating high-speed and high-altitude aircraft that combined good flight performance characteristics with reduced radar detectability. The American series-produced Lockheed SR-71 and the Soviet experimental RSR were such aircraft.*

**RSR**

**Versions.** NM-1 (1959)—experimental analogue aircraft.

**Crew.** One.

**Dimensions.** Wingspan (along outer lateral surfaces of engines) 10.36 meters, area 58.4 $m^2$, wing sweep angle at leading edge 58°, length of fuselage 28 meters.

**Mass.** Maximum takeoff mass 21,000 kg [kilograms], landing 9,200 kg, fuel (kerosene and propane) 12,000 kg.

**Flight characteristics.** Top speed 3,000 km/hr; operational ceiling (at Mach 2.65) 26.7 km, dynamic ceiling 42 km; flight range at altitude of 20 km at greater than Mach 2, 3,760 km; landing speed 245 km/hr; landing runout 1,200 meters; maximum operational G-forces 2.5. The aircraft was expected to be able to be operated from class two airfields.

**Engines.** D-21 TRDDs [turbojet bypass engines] (developed by OKB-19 [Experimental Design Bureau-19] of P. Solovyev, 2 x 4,500—5,000 kgf in takeoff mode and 2,200 kgf in cruising mode).

**Equipment.** Radar sight with photo attachment (surveillance range up to 250 km against area targets), electronic reconnaissance set, photographic gear, including two aerial cameras with focal length of 1,000 mm and two with focal length of 200 mm, or one with a focal length of 1,800 mm and two with a focal length of 200 mm, optical sight, radar-illumination warning set, active and passive jamming gear, inertial-celestial navigation system, vertical gyro, autopilot and heading system.

**Design features.** Bicycle type landing gear. The presence of a braking chute was planned.

The airframe skin was made of D-16T and D-20 aluminum alloys and aluminum-beryllium alloy.

**Additional information.** Vigorous and extremely successful work was launched in the USSR in the 1950s on high-speed, high-altitude aircraft in various classes. The OKBs of S. Lavochkin and V. Myasishchev were creating the Burya and Buran unmanned cruise aircraft, designed for intercontinental flight and equipped with cruising PVRDs [ramjet engines] with acceleration to cruising speed of Mach 3 in a vertical launch from the ground using liquid-fueled rocket booster engines. Work was underway on similar topics at other OKBs as well.

The development of a plan for a manned, supersonic long-range bomber and jet-powered reconnaissance aircraft was underway at OKB-256 starting in 1955 under the leadership of P. Tsybin. The distinctive features of the design were the use of an air launch from a Tu-95N launch-platform aircraft, with subsequent acceleration to a cruising speed of 3,000 km/hr using two paired liquid-fueled booster engines and a cruising flight using two PVRDs. The total design range of the reconnaissance aircraft was 12,500—13,500 km. A preliminary design of the aircraft was prepared in January 1956, but in 1957 the work on the reconnaissance aircraft was halted (one reason was the impossibility of achieving the design bomb load, which was a high-yield thermonuclear bomb).

The OKB-256, simultaneously with the start of work on the reconnaissance aircraft, prepared a proposal for the creation of a supersonic jet reconnaissance aircraft to conduct operational reconnaissance in a theater and the enemy rear.

A government decree was issued on 31 August 1956 for the creation of a high-altitude, high-speed reconnaissance aircraft, and on 15 January 1957 the TTT [technical-performance requirements] for an aircraft that received the designation RSR were issued.

The RSR, according to them, was to be the first manned aircraft in the world with a supersonic cruising speed. It could reach almost three times the speed of sound at an altitude of 25.5 km over a target. The preliminary design for the RSR reconnaissance aircraft that was completed on 26 June 1957 confirmed the practicability of achieving the design characteristics. The RSR could climb to an altitude of 20 km 15 minutes after takeoff.

It was expected that the aircraft would pass the speed of sound at an altitude of 8.5 km four minutes after takeoff. The jettisoning of the external fuel tanks was planned at an altitude of 10.7 km at a speed of 420 meters/second, and after a gain in altitude prolonged flight would occur at high supersonic speeds.

The RSR was to maintain radio and radar silence during the flight. Attention was devoted during its creation to providing for a small radar signature through the use of the appropriate shapes for the airframe surfaces and the use of radio-absorbing skin coatings (one of the first attempts at reducing radar detectability). The execution of a brief maneuver with G-forces up to 2.5 was also envisaged in order to evade missiles (a zoom with a dynamic ceiling of 42 km), along with the use of active and passive jamming.

A manned analogue aircraft, the NM-1, was built to try out the design and on-board systems of the RSR; it was fitted with two AM-5 TRDs [turbojet engines] (2 x 2,000 kgf) and had a takeoff mass of nine tonnes, length of 26.5 meters and wingspan of 7.71 meters. The landing gear of the NM-1 had a main support in the form of a skid in the central part of the fuselage, and a takeoff trolley with two wheels that was attached to the skid. The first flight took place on 7 April 1959 (the test pilot was Amet-Khan Sultan). More than ten flights were made by the NM-1 in all.

Despite the fact that the manufacture of a pilot series of five RSR aircraft was organized at a plant in Ulan-Ude and the possibility of assembling it at the Plant imeni Khrunichev in Moscow was studied, the OKB-256 was closed by decision of N. Khrushchev, and the work on the aircraft was transferred first to the OKB-23 of V. Myasishchev, and then to OKB-52 of V. Chelomey, where it was "happily" put to rest, being in contradiction with the principal projects of OKB-52. The series of RSR aircraft was actually manufactured, in the recollection of test pilot V. Pazhitnyy, who was working at the plant in Ulan-Ude at the end of the 1950s and beginning of the 1960s, but the delivery of engines was held up when the plant management received a directive to shut down the program and cut up the aircraft. The workers refused to destroy the fruits of own labor with their own hands. The management "displayed flexibility," and the aircraft were mothballed; three or four years later they were quietly taken away for scrap.

### Lockheed SR-71A

**Versions.** SR-71B, C—training aircraft, distinguished by the altered shape of the cockpit and the lower fins under the engine nacelles.

**Crew.** Two.

**Dimensions.** Wingspan 16.94 meters, area 149.1 m$^2$, sweep angle at leading edge 60°, length of aircraft 32.74 meters, height 5.64 meters.

**Mass.** Maximum takeoff weight 78,020 kg, empty aircraft 30,618 kg; fuel volume 46,180 liters.

**Flight characteristics.** Top speed 3,220 km/hr at altitude of 24,000 meters, 2,125 km/hr at altitude of 9,150 meters; operational ceiling 24,400 meters; range with one aerial refueling (Mach 3, altitude 24,400 meters) 4,800 km; maximum flight duration in that mode, 1 hour 30 minutes; takeoff run length 1,645 meters at mass of 63,500 kg, length of runout with minimum mass 1,100 meters.

**Engines.** Pratt & Whitney JTIID-20B TRDFs [afterburning turbojet engines] (2 x 10,340/14,740 kgf).

**Design features.** About 93 percent of the aircraft structural elements by weight are manufactured of titanium alloys.

**Equipment.** Inertial-celestial navigation system, stability improvement system, autopilot and trim system by Mach number. Equipment for strategic (encompassing an area of 259,000 km$^2$ in one hour from an altitude of 24,400 meters) and conventional image reconnaissance over the battlefield; electro-optic (ELINT) and radio (COMINT) reconnaissance gear, including infrared and laser systems, short-focal-length panorama aerial cameras with focal length of 610 mm, long-focus aerial camera for lateral perspective pictures (LOROP type. lens with focal length of 1,680 mm, resolution of 76 cm at a range of 96 km), EW system and aerial refueling using a telescoping boom.

**Status.** Series-produced in 1966-67 (32 aircraft were built, including trainers). There were two air wings with nine SR-71A/B aircraft each in the Strategic Air Command by the beginning of 1989. The decision was made to remove the aircraft from service that same year. The sole flying model of the SR-71A at the beginning of 1992 was being operated by NASA as a flying laboratory.

**Additional information.** Work began at the end of the 1950s on the creation of a new strategic reconnaissance aircraft intended to replace the Lockheed U-2. The principal requirements were for a high ceiling and high cruising speed (Mach 4). Since the interception of such a target was possible only using radar, the necessity naturally arose of reducing the aircraft's radar signature without altering the altitude and speed characteristics.

The firms of General Dynamics (a design for a small aircraft manufactured with the partial use of ceramics, fitted with PVRDs and launched from the air by a B-58 launch platform) and Lockheed, which under the leadership of K. Johnson had developed a design for an aircraft with a delta wing and two PVRDs, took part in the competition to create the new reconnaissance aircraft. Lockheed proposed reducing the aircraft's radar signature through the appropriate shape of the airframe, with smooth junctions between the wing and fuselage and a twin-tailed empennage tilted inward (the design also projected the use of radar-absorbing materials, but the lack of a suitable means of calculating the radar signatures of aircraft in the 1950s did not allow them to achieve any substantial reduction in radar detectability).

Lockheed was deemed the winner of the competition, and in 1959 it was given a contract to develop the new aircraft. A variation of the F-12A fighter was created at the same time (obviously the U.S. Air Force command had a certain amount of unease at the time regarding the successes of the USSR in creating supersonic strategic aircraft). The flight of the first experimental F-12A took place on 26 April 1962, while the official demonstration for the press of this previously secret aircraft was organized on 1 October 1964.

The first flight of the reconnaissance aircraft that received the designation SR-71A took place on 22 December 1964; it went into series production (start of delivery in 1966) and was widely employed in the interests of the CIA and the U.S. Air Force for more than 20 years.



## Layout, Facilities of Plesetsk Cosmodrome

*94UM0034F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 40-41*

[Article by Major-General (Reserve) B. Morozov, chief of the cosmodrome space units from 1986 through 1990, under the rubric "Cosmodromes: Missiles and People": "Plesetsk"]

[Text] July 15, 1957 is considered to be the official date of the creation of the northern cosmodrome. Built initially by military construction personnel as a scientific-research test range for missile technology, it gradually came to be one of the principal domestic cosmodromes. About 1,500 spacecraft (60 percent of the total number) have been put into orbit from here. They include satellites for military, scientific and national-economic purposes. Located 800 km [kilometers] from Moscow among forests, lakes and peat bogs, the cosmodrome occupies an area of about 10,000 km$^2$ (120 km from north to south and 80 km from east to west), and is a complicated technical complex for the preparation and launching of artificial Earth satellites.

The choice of the location for the cosmodrome was no accident. Many scientific, national-economic and military programs require the placement of spacecraft into low polar and near-polar orbits. The use of launch complexes that are located in the higher latitudes is expedient for this purpose. The active portion of the flight of launch vehicles also passes over the lightly settled terrain of Arkhangelsk Oblast, which makes it simpler to provide for safety along the flight path of the rockets and choose the areas where the spend stages fall (northern Tyumen Oblast and Taymyr Peninsula). The proximity of the cosmodrome to the country's scientific and production centers was also taken into account.

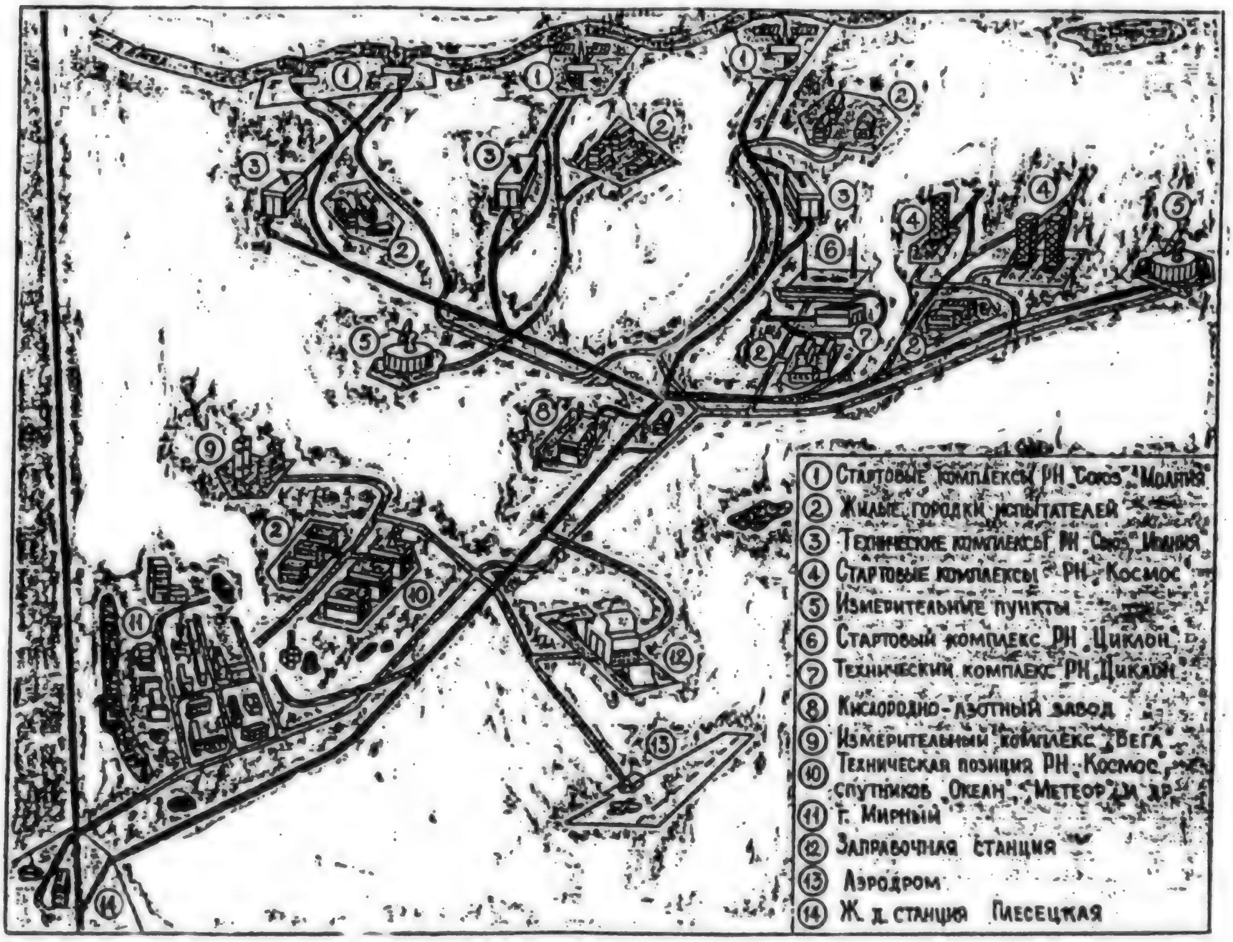
The city of Mirnyy, not shown on many maps, is located seven kilometers from the Plesetsk station on the Northern Railroad. The test personnel live there. The population of the city and the residential compounds of the centers for the preparation of launch vehicles and spacecraft for launch varies from 40,000 to 60,000 people. The infrastructure of Mirnyy meets all contemporary requirements. The city is provided with heat, water, electric power, foodstuffs and industrial goods mainly by servicemen. The sights, aside from monuments to prominent figures in space science, include memorials to the tragic events that have occurred at the cosmodrome and memorable dates on the occasion of the launches of the Kosmos-500, Kosmos-1000 and Kosmos-2000 satellites, among others. There is an instrument-building technical school, a branch of the Novator VNII

[All-Union Scientific-Research Institute] of Electronic Machine Building and the Pero airfield.

There is an engineering site next to the city for the launch preparation of light (from 800 to 3,000 kg [kilograms]) spacecraft and their launch vehicles. Testing of satellites (aside from military ones) in the Kosmos, Interkosmos, Okean and Nadezhda series, among others—about 20 types of spacecraft in all—is conducted in the installation and testing wings. The stages of the Kosmos launch vehicle are also joined and tested here before being brought out to the launch complex.

There are servicing areas for each craft and launch vehicle with sets of ground testing equipment. The check-out processes are highly automated. Some spacecraft, such as the Meteor, can be delivered by aircraft to the Baykonur cosmodrome for launch into heliosynchronous orbits after they are checked out.

Rockets for space purposes (the rocket and spacecraft covered by a cowling) that are prepared for launch are delivered on transport and placement units to the launch pad located 50 km from Mirnyy, where they are placed on the launcher




Key:
1. launch complexes for the Soyuz and Molniya launch vehicles
2. residential compounds for test personnel
3. engineering complexes for Soyuz and Molniya launch vehicles
4. launch complexes for the Kosmos launch vehicles
5. telemetry stations
6. launch complex for the Tsiklon launch vehicle
7. engineering complex for the Tsiklon launch vehicle
8. oxygen and nitrogen plant
9. Vega telemetry complex
10. engineering site for the Kosmos launch vehicle and Okean and Meteor *et al.* satellites
11. city of Mirnyy
12. refueling station
13. airfield
14. Plesetsk railroad station

and are located inside a movable service tower during pre-launch preparations. This structure is 100 meters high, with an area of 2,000 $m^2$ at the base and a weight of 450 tonnes. The tower is retracted from the rocket before launch on railroad tracks 12 meters apart. A spacecraft can be changed on a vertically positioned rocket using it, as opposed to other launch complexes. It also supports the normal functioning of the service personnel under any weather conditions and at any time of day. Deep enclosures are located near the launch complex, housing storage areas for the rocket fuel components and the engineering and technological preparation systems.

Spacecraft checked out and ready for launch by the Tsiklon launch vehicle are delivered from the engineering site in the installation and testing wing, located 40 km from the city, where they are joined with the rocket and transported to the launch complex. The mounting, hook-up of all service lines and pre-launch checks for these rockets are entirely automated. The operation of on-board and ground technological systems and units is monitored using an automated control system, with the depiction of the technological schedule on the display of the main operator. Manual control of the launch can be used when necessary. The pre-launch structures (storage areas for the rocket fuel components, accommodations for the ground testing equipment, panels and the like) provide for the complete safety of the personnel in launch.

The engineering and launch sites where medium-class launch vehicles and spacecraft are prepared and launched are located 40—45 km from Mirnyy. They include four standardized launch complexes 10—15 km apart located on the steep bank of the small taiga river Yemtsa. This makes it possible to perform not only simultaneous pre-launch preparation, but also timely technical servicing and upgrading. One of their specific features is the fact that the gas diversion lines of the launch structures have been run out to the river floodlands in the interests of fire safety, which made their construction considerably cheaper. All the launch pads may be used for manned spacecraft. The Soyuz and Molniya launch vehicles and the spacecraft (military, Kosmos, Bion and Resurs series and the like) are tested in four installation and testing wings. Each rocket and craft has its own equipped servicing areas, some of which are standardized and suitable for the testing of both military and civilian craft. More than ten types of satellites may be tested in all.

The telemetry complex includes the Vega system of external trajectory measurements, two telemetry stations on the grounds of the cosmodrome and four along the flight path of the launch vehicles in the area of Vorkuta, Norilsk and Syktyvkar and on Novaya Zemlya. The information coming in from them is processed at the computer center in Mirnyy. Its capacity is such that it could satisfy the requirements of all of Arkhangelsk Oblast in the resolution of national-economic tasks.

The oxygen and nitrogen plant provides all the launches with the necessary liquefied gases.

The cosmodrome continues to develop. Launch and engineering complexes for the Zenit launch vehicle and the spacecraft launched by that rocket will enter service in the next few years.



## Soviet Intercontinental Cruise Missiles Developed in 1950s

*94UM0034G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) pp 42-44*

[Article by I. Afanasyev under the rubric "Without the Secret Stamp": "'Halt the Work, Destroy the Materials'"]

[Text] *The unprecedented aircraft, remotely reminiscent of the Space Shuttle, was launched in columns of fire and smoke on the broad rectangle of the screen—an aircraft with a delta wing, lifted by two powerful rocket boosters—and went off into the sky leaving behind a track of many kilometers. When the solemn sounds of the music had fallen silent and the movie screen lit up, the viewers applauded in concert and genuinely. That is how the participants in the 17th Scientific Readings on Space Science of 1993, among them the creators of the Burya intercontinental cruise missile, welcomed the news that the lid of secrecy had finally been removed from the object whose fate had been carefully concealed from the domestic and world community more than thirty years ago.*

After 29 August 1949, when the USSR detonated its first nuclear device, the United States had to reconsider its views of the problem of the "big stick against the Russians." The first stage in strategic parity, however, was achieved only when the first experimental prototypes of bombers with intercontinental flight range appeared at the design bureaus of A. Tupolev and V. Myasishchev. They knew about this in the United States.

But taking into account the prospects for the development of air defenses by a potential enemy, it was necessary to create new and less vulnerable means of delivering nuclear weapons. The principal flight characteristics and look of systems that had the necessary range were determined in the course of research, and two basic ways of developing them were noted—the creation of intercontinental ballistic missiles (ICBMs) and supersonic winged craft. Both the former and the latter had their advantages and disadvantages. While it was difficult even to imagine the means of destroying a flying ICBM at the beginning of the 1950s, the vulnerability of winged craft seemed to be too great. Their principal defense at the time was only altitude and speed. The creation of ICBMs, however, required providing a very high weight efficiency in the design for the times, as well as powerful and economical engines and an accurate, autonomous guidance system, also not easy to do. The requirements for the structural elements and power plants of supersonic strategic bombers and intercontinental cruise missiles (MKRs) were not as high; experience accumulated earlier in aircraft construction was widely employed in their design engineering. A system of celestial navigation on MKRs could ensure high accuracy in hitting the target. The decision was made, in order to guarantee the safety of the country, to develop MKRs, supersonic bombers and ICBMs.

M. Keldysh was the inspiration for the idea, and the theoretician for the creation, of the ICBMs and MKRs. The NII-1 [Scientific-Research Institute 1] that he headed was given the task of creating a theoretical-design base for the

future systems. The Experimental Design Bureau (OKB) of S. Korolev was to incarnate the missile in metal.

A supersonic ramjet engine (SPVRD) was considered to be preferable for the power plant (DU) of the MKR; its operating efficiency reached a maximum at a constant (cruising) speed corresponding to Mach 3—3.5. The work on the SPVRD was advanced most broadly at NII-1 and the OKB headed by M. Bondaryuk. Since this engine operated steadily and economically only within a comparatively narrow range of speeds and altitudes, rocket boosters were required to put the MKR onto the flight trajectory before the start of the cruising leg.

The SPVRD differed from other types of jet engines in the simplicity of its design. It had no compressor to compress the air before being fed into the combustion chamber; it actually consisted of an air intake—diffuser in which the air flow was slowed, raising the pressure thereby, a combustion chamber, and an exhaust nozzle that transformed the potential energy of the hot gas into kinetic energy.

The guidance system determined the accuracy of warhead delivery. Work on celestial navigation systems apropos of cruise missiles was being pursued at the end of the 1940s at the initiative of B. Chertok at NII-88, which at that time was a part of the OKB of S. Korolev. The design department of I. Lisovich, who in 1953 developed an operating celestial navigation system with the necessary characteristics, was also created there.

The heat-resistant structural materials without which the manufacture of the MKR was impossible—titanium, high-strength stainless steel—as well as the technology for machining and welding them, were under development at VIAM [All-Union Scientific-Research Institute of Aviation Materials] and MVTU [Moscow Higher Technical School] imeni N.E. Bauman.

They decided first to build an experimental cruise missile (EKR) with a cruising speed of Mach 3 and a range of 1,300 km, the design for which was developed at the OKB of S. Korolev in 1951-53, in order to check out the possibility of realizing supersonic cruise missiles. Like a full-scale MKR, it was to consist of a booster with ZhRDs [liquid-fueled rocket engines] (the R-11 rocket with long-term storable fuel) and a cruising stage with an SPVRD developed by the OKB of M. Bondaryuk. It should be taken into account that virtually no one, either in our country or abroad, had any experience in the creation of SPVRDs with the required characteristics. Relying on the comparatively modest experimental elaborations of past years and quite substantial scientific work in progress at the NII-1, the necessary engine was created in the shortest possible time and passed through the whole set of ground try-outs, confirming its design characteristics.

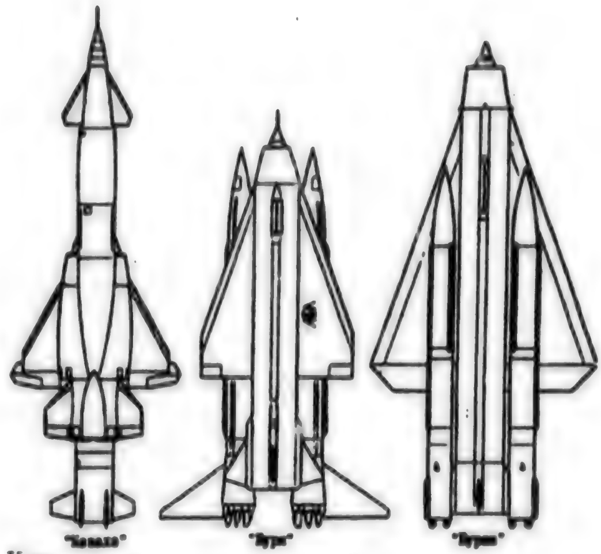
Reporting to the leadership of the USSR the completion of working design engineering for the EKR, representatives of the expert commission affirmed that the amount of research that had been performed was so great, while the data obtained from the ground testing satisfied the requirements of the customer so well, that the possibility existed of foregoing the completion of the experimental missile and its flight testing. An immediate move to the physical development of the MKR using the manpower of aviation design collectives, rather than "missile" ones, and the accumulated design work of the EKR was proposed. The Korolev OKB could concentrate all of its efforts after that on the creation of ICBMs, which no one had rejected either.

A decree came out on 20 May 1954 on the start of development of two parallel MKR projects, the Burya and the Buran, the creation of which was entrusted respectively to the OKB of S. Lavochkin—which at the time had experience in building supersonic fighters and had moved on to the new subject matter—and the OKB of V. Myasishchev, which was developing long-range supersonic bombers. The main executor of the SPVRD for both missiles was the OKB of M. Bondaryuk. The celestial navigation guidance system was being created under the leadership of R. Chachikyan, while the inertial guidance system for the operating leg of the launch boosters was under the leadership of G. Tolstousov. The scientific research of all subdivisions of the NII-1 and the corresponding departments of the Institute of Applied Mathematics was directed toward supporting the solutions of the tasks of the OKBs of Lavochkin and Myasishchev.

Soviet MKRs were designed as unmanned supersonic aircraft with vertical launch. The launch and reaching of cruising speed were expected to be accomplished using powerful boosters with liquid-fueled rocket engines. The booster engines of the Burya were developed by the OKB of A. Isayev, while those for the Buran came from the OKB of V. Glushko. Both, at the recommendation of TsAGI [Central Institute of Aerohydrodynamics imeni N.Ye. Zhukovskiy], were two-stage craft, with the second (cruising) stages fitted with SPVRDs structured according to a normal aircraft configuration with a delta wing, a sweep angle at the leading edge of 70° and a thin, supersonic profile. The forward portion of the cylindrical fuselage of the cruising stage held a supersonic diffuser with a central body, in which was accommodated the warhead. The air-intake duct led back to the tail section of the fuselage where the SPVRD was installed, encircled by annular fuel tanks; the fuselage ended in the SPVRD nozzle and X-shaped empennage with aerodynamic control surfaces. The system of celestial navigation and control was located in a cooled instrument compartment in the upper front part of the fuselage; its sensors were covered with a unique kind of canopy made of heat-resistant quartz sheets.

The dimensions and design execution of the individual systems and units of both MKRs were different. Since the Buran was designed for a larger warhead than the Burya, it had a large takeoff mass and thrust of both the cruising and the launch engines. The work of the Lavochkin OKB outstripped the plans, and by 1956, when the Myasishchev OKB was finishing the design engineering of the Buran, the first models of the Burya had already been created.

It is interesting that they were informed abroad about the Soviet work on the MKRs. The authors of the "International Handbook on Controlled Shells and Spacecraft," published in the United States in 1960 by F. Ordway and R. Wakeford, described in a great deal of detail the "large winged antipodal T-4A bomber under development in the USSR," and even included a drawing. The aircraft depicted in it resembled the Burya. They assumed that the Soviet projects were based on the research of German scientists E. Senger and I. Bredt on a super-long-range rocket aircraft during World War II.



Key:
left—Navaho
center—Burya
right—Buran

After comprehensive ground testing of the Burya that was successfully completed in full, a new stage in the work started in July of 1957—flight testing. The first seven launches were to try out the initial leg of the flight of the Burya until the moment of booster separation; the aim of the next three flights was to run through the dynamics of the separation of stages and the ignition of the cruising stage. The second part of the program of flight testing envisaged flights with an operating cruising engine—first for a short distance, and then for a long one—with the actual try-out of all the units. By March of 1960 the MKR had demonstrated the possibility of stable flight and the operability of all systems. The missile was launched before dawn in the last launch, made on December 16 of that same year, with the cruising flight during the daytime, which proved the effectiveness of the operation of the celestial navigation at any time of day. The planned program of flight testing had been completed.

The flights of the Burya took place at the same time as the flight testing of the R-7 ICBM developed by the Korolev OKB. The leadership of the USSR decided soon afterward to curtail the work on the Buran, assuming that the country could not "pull off" two MKR projects with similar characteristics at the same time. This step made the advocates of the idea of a MKR somewhat wary, but it did not particularly upset them—they were objectively justified.

The work on the Burya proceeded with unusual creative enthusiasm. Its creators understood that they were making more than a weapon—they were getting the last word in aviation and missile technology, looking to tomorrow. Against that background, the order of the leadership of the sector, the essence of which could be reduced to the following phrase, made a stunning impression: "Halt the work, destroy all materials..."

Yes, everyone could see that Korolev's "seven" had begun to fly successfully, but was it then worth it to drop the MKR, which had also fulfilled its mission? The decision was made in entirely unwarranted fashion, in the opinion of a number of specialists taking part in the Burya project. But the higher state leadership, after the launch of the R-7, was in a state of euphoria, and the Americans had curtailed their work on the analogous Navaho MKR by 1958 anyway. Air-defense missiles and interceptor fighters able to counter such MKRs effectively were also being developed at that time. ICBMs seemed invulnerable at the time.

Despite the rapid curtailment of the work on the MKRs, their results were widely utilized in the future in aviation and space, as well as missile, engineering. A domestic school of SPVRDs was actually created using the engines from the Burya and Buran. The engineering ideas that were verified in them were moreover made inherent in the designs of many ramjets installed in air-defense and cruise missiles that are in service to this day.

They returned to MKRs considerably later, in a new stage in the development of aircraft and missile technology when mobility and operativeness in delivery, along with low detectability and high accuracy, had moved to the forefront. And here the experience of the Burya, reflected in the mirror of contemporary science and technology, proved useful.

**Comparison of Design Characteristics of the Navaho, Burya and Buran MKRs**

| Characteristics | Navaho | Burya | Buran |
|---|---|---|---|
| Launch mass, tonnes | 66.2 | 96 | 125 |
| Mass of warhead, tonnes | 2.25 | 2.19 | 3.50 |
| Total length of system, meters | 25.1 | 19.9 | 24.0 |
| **Boosters:** | | | |
| Quantity | 1 | 2 | 4 |
| Length, meters | 23.1 | 18.9 | 19.1 |
| Diameter of body, meters | 1.83 | 1.45 | 1.20 |
| Thrust at launch, tonnes of force | 128.45 | 2 x 68.61 | 4x55 |

**Comparison of Design Characteristics of the Navaho, Burya and Buran MKRs (Continued)**

| Characteristics | Navaho | Burya | Buran |
|---|---|---|---|
| **Fuel components:** | | | |
| oxidizer | liquid oxygen | nitric acid | liquid oxygen |
| combustible | ethyl alcohol | amines | kerosene |
| **Cruising stage:** | | | |
| Length, meters | 20.7 | 18.0 | 23.3 |
| Diameter of body, meters | 1.83 | 2.20 | 2.40 |
| Wingspan, meters | 8.72 | 7.75 | 11.6 |
| Wing area, $m^2$ | 38.9 | 60 | 98 |
| Number of SPVRDs | 2 | 1 | 1 |
| Diameter of SPVRD, meters | 1.22 | 1.70 | 2.00 |
| Cruising thrust, tonnes of force | 2 x 3.94 | 7.65 | 10.6 |
| Maximum range of flight, km | 5,400 | 8,500 | 8,500 |
| Cruising altitude of flight, km | 22—24 | 18—20 | 18—20 |
| Cruising speed of flight, Mach | 3.25 | 3.10 | 3.10 |
| Start of development | 1950 | 1954 | 1954 |
| Date of start of flight testing | 6 Nov 56 | 1 Jul 57 | — |
| Total number of launches | 11 | 17 | — |
| of which, failed | 10 | 3 | |
| Date of end of flight testing | 18 Oct 58 | 16 Dec 60 | — |
| Shutdown of project | July 1957 | December 1960 | — |



## French 'Spot' Photo Satellite Has Commercial and Military Uses

*94UM0034H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, Jun 93 (signed to press 26 May 93) p 47*

[Article by Candidates of Technical Sciences A. Dubovoy and S. Baskov, experts of the Association of Practitioners of Space Science, under the rubric "Space Science Abroad": "The 'Spot'—Commerce or Reconnaissance?"]

[Text] Space systems for Earth observation have traditionally been divided into civilian and military reconnaissance. Many countries, however, can purchase and use the information obtained by civilian satellites as reconnaissance information if they do not possess their own space hardware.

One visible example of this is the commercial application of the French Spot-1 remote Earth sounding satellite, equipped with two cameras with a resolution of 10 meters in the visible and 20 meters in the visible and near infrared spectrums. Its first launch into space from the Kourou space facility into a heliosynchronous orbit 832 km [kilometers] high was accomplished by an Ariane launch vehicle in 1986. This resolution of the special gear makes it possible to distinguish many objects—roads, buildings, the dividing strips between agricultural lands etc., but the pictures obtained are not considered to be reconnaissance pictures in accordance with a decision by the French government. This became the pledge of commercial success for the firm of Spot-Image, which had captured half of the world market for the sale of satellite data as early as 1987. A broad opportunity appeared for the acquisition and use of photography of various sections of the Earth's surface, including secret military facilities and the areas of combat operation and weapons deployment, by governments, organizations and the mass media.

The fact that the information being disseminated could be used for reconnaissance purposes was not only not a secret, but was even vigorously advertised. Assistance was offered in some materials for the identification of targets outside the limits of accessibility of reconnaissance aircraft, including determination of the positions of air-defense complexes, the structuring of stereoscopic depictions of them and the approach routes to targets. It was also pointed out that high-precision digital models of the terrain created using the information obtained from the spacecraft make it possible to create databases for target designation for ground-attack aviation.

Many foreign specialists feel that the use of civilian remote Earth sounding satellites in the interests of various agencies, including military ones, is the sole expedient way of making highly efficient use of expensive space hardware. There are few scientifically sophisticated and very expensive reconnaissance systems of the American KH-11 type. The opportunity thus appears, to the extent of improvements in the quality of information from commercial satellites and reductions in the time between requests and the receipt of materials, for the use of the necessary data in a large number of fields with relevance to national security. The U.S. Defense Department, for example, spent six million dollars in 1990-91 for the procurement of 5,000 photos from the Spot satellites from the American affiliate of the Spot-Image

firm in Reston (Virginia). Some of them (data on 24 airfields in the former USSR) were employed in laying out routes to non-traditional destinations for the U.S. Air Force, to ensure the safety of flights of American C-5 and C-141 military-transport aircraft delivering humanitarian aid to our cities.

There were about 240 portable systems for flight support available to the U.S. Air Force at the beginning of 1992, which could be programmed for the automatic modeling of images of sections of terrain from any flight altitude according to the information from Spot. The systems compare photos from the spacecraft with digital geometric data on the terrain. The use of this technology was launched after its successful utilization during the war in the Persian Gulf.

Another interesting direction is the use of these satellites for monitoring in the interests of maintaining peace and international security. The Carnegie Worldwide Assistance Fund was engaged in a study of this problem in 1988. Pictures from the Spot and Landsat satellites and some other space systems were studied. It was established that the Spot apparatus made it possible to obtain images with high resolution that contained more useful information than the Landsat pictures. All bridges proved to be detectable in them, and measurement of the images made it possible to obtain such important characteristics as the traffic capacity of bridges. They were also able to determine the deployment areas of headquarters, barracks and other buildings, and the sites of motor-vehicle pools, airports and air bases. Boeing-727 aircraft were also visible in the pictures.

The international community, based on the results of the Carnegie Fund, has been discussing the possible creation (with the presumed participation of the United Nations) of means to provide for arms control in the interests of preserving peace and stability. The tasks that could be accomplished with the aid of such a space system include monitoring the observance of arms treaty obligations, cease-fires and troop disbanding, as well as supporting the efforts of popular diplomacy to defuse tense situations.

Proceeding from this, the trend toward increasing the resolution of the photos received remains as topical as before. The Spot-4 spacecraft, planned to be launched in 1995, will be equipped with modern HRVIR high-resolution cameras (visible and near and middle infrared bands).

The Helios satellite is presumably being developed on this basis in two versions—for reconnaissance in the optical band and for radar reconnaissance. The resolution at the ground in the optical band is expected to be no worse than one meter in surveillance from an altitude of 600—700 km. The frequency of observation of a system of two spacecraft should be one day.

Italy and Spain are taking part in the Helios project along with France. The first launch of the satellite is planned for 1994, and the second in 1997. The extent to which they will be able to be used as commercial satellites can be judged after their launch.

**Footnote**

1. Based on materials in the foreign press.



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